IV. "The Micro-organism of Distemper in the Dog, and the Production of a Distemper Vaccine." By Dr. S. Monckton Copeman. Communicated by Sir M. Foster, Sec. R.S.

V. "On the Tempering of Iron hardened by Overstrain." By James Muir. Communicated by Professor Ewing, F.R.S.

"The Histology of the Cell Wall, with special reference to the Mode of Connection of Cells."* By Walter Gardiner, M.A., F.R.S., Fellow and Bursar of Clare College, Cambridge, and Arthur W. Hill, B.A., Scholar of King's College, Cambridge.

Part I.

"The Distribution and Character of 'Connecting Threads' in the Tissues of *Pinus sylvestris* and other Allied Species." By Arthur W. Hill, B.A., Scholar of King's College, Cambridge

Received July 17,—Read December 6, 1900.

(Abstract.)

The research with which this paper is concerned was undertaken with a view of ascertaining to what extent "connecting threads" are distributed throughout the body of any given plant, and for this purpose the endosperm and the various tissues of the hypocotyl, cotyledons, and root of the young seedling of *Pinus pinea*, and of the adult stem leaf and root of *Pinus sylvestris*, were examined.

The results show that the presence of such threads can be readily demonstrated in the case of all cells in which the wall retains its cellulose or mucilaginous character, and that in such young tissue as the growing point of the root all the cells are provided with connecting threads. When the lignified or suberised condition has supervened it is difficult or impossible to identify threads, though even in such cases threads may be recognised in certain of the very young elements.

In *Pinus pinea* the tissue of the endosperm, as also that of the germinating seedling, is well connected by threads.

In the cotyledon the absorptive side next the endosperm (corresponding to the lower side of the leaf) shows a certain histological distinction in that the walls of the cells, both of the epidermis and of the subjacent parenchyma, are more richly provided with threads than are the similar tissues of the upper side. No threads, however, occur

* For the preliminary communication on this subject, see Gardiner: "The Histology of the Cell Wall, with special reference to the Mode of Connection of Cells," 'Roy. Soc. Proc.,' vol. 62, 1897.

in the outer or free walls of the epidermis, so that diffusion only (as opposed to direct transference) can take place between the cell contents of the endosperm and those of the cotyledon.

In the stomata of the cotyledon threads have been seen in a few cases connecting the guard cells with the epidermal cells.

The parenchymatous tissue all over the seedling plant shows connecting threads of a similar character. In the end walls of the cells they occur irregularly scattered, but in the lateral walls they are usually in isolated groups, mainly in consequence of the growth in length which these walls have undergone, and are also situated in shallow pits.

The palisade cells of the cotyledon, which at first are united together in all directions, very soon separate, forming plates of tissue, and the threads in the walls along which separation takes place are very quickly obliterated. A similar obliteration of threads is seen to occur in those walls of pericyclic cells which are situated between the living cells and the young transfusion cells in process of lignification.

The living cells of the pericycle, which are richly connected together by threads, form the passage cells from the cortical tissues to the phloem, and between these cells and the sieve tubes come the albuminous cells, which possess thread groups occurring in localised thickenings of their walls. The threads, which are long and usually curved, stain in a peculiar manner, and appear to have an important function with reference to the passage of material from the mesophyll to the phloem.

The phloem tissues of the seedling of *Pinus pinea* present a distinct type, the peculiarities of which are treated of at some length. The large cells of the outer portion are characterised by long oblique end walls full of threads; whilst the thick-walled cells of the inner part possess square end walls traversed by numerous long threads, resembling the sieve tubes of dicotyledons. As development proceeds, sieve tubes like those of the adult tissues are, however, quickly developed from the cambium. All the sieve tube threads show a characteristic median dot.

The root cap of the seedling root shows numerous threads connecting its cells together, and also affording communication both with the free surface of the root as well as internally with the cells of the periblem. The function of the root cap as an organ for stimulus perception and as an absorbent organ is considered with reference to the abundance of the connecting threads.

In *Pinus sylvestris* the characters of the threads in the cortical tissues of the adult stem and root are similar to those of the seedling. Threads occur, however, in the radial and end walls of the cells, but in the cells just under the cork they are distributed in large numbers in the tangential walls, and this change in the main direction of the

threads points to their value as a means of conducting food material to the developing cork.

In the phloem there is a sharp contrast between the starch-containing medullary ray cells and bast parenchyma on the one hand, and the sieve tubes on the other, and no threads can be found directly connecting the parenchymatous cells with the sieve tubes, but the albuminous cells of the ray possess numerous thread groups which communicate with both tissues. The starch medullary ray cells in the phloem and xylem possess numerous threads in the tangential and basal walls, especially in the former, and are also united with the bast parenchyma and albuminous cells.

The sieve tube threads which occur only in the radial walls always show a median dot.

The existence of threads in the xylem is doubtful. All living parenchymatous cells show them, but it seems probable that they quickly disappear when the cells become lignified. In the case of young bordered pits there is some evidence that the torus is traversed by connecting threads which are soon obliterated.

The leaf of *Pinus sylvestris* shows a distribution of connecting threads similar to that noticed in the cotyledon. The endodermis is seen to be an important layer connecting the tissues of the stele with those of the cortex by means of thread groups in the tangential walls. In the pericycle there are both dead and living cells, but no threads persist in the walls connecting the dead with the living cells.

The albuminous cell thread groups are very well developed, and their function and peculiar properties are discussed.

In conclusion, the general distribution of the connecting threads throughout the tissues is considered.

"On the 'Blaze Currents' of the Frog's Eyeball." By A. D. Waller, M.D., F.R.S. Received December 6,—Read December 6, 1900.

(Abstract.)

The normal electrical response to light is positive. The normal electrical response to every kind of stimulus is positive. The normal response of the frog's eyeball is partly retinal, partly by other tissues. The direction of response is reversed by pressure.

The normal "blaze currents" excited by single induction shocks, and by condenser discharges, are comparable with the normal discharges of an electrical organ. Their maximum voltage is of the same order as that of the discharge of a single electrical disc (over